Development of Multi-Lock Biopolymers Degradable in Ocean From Non-Food Biomasses

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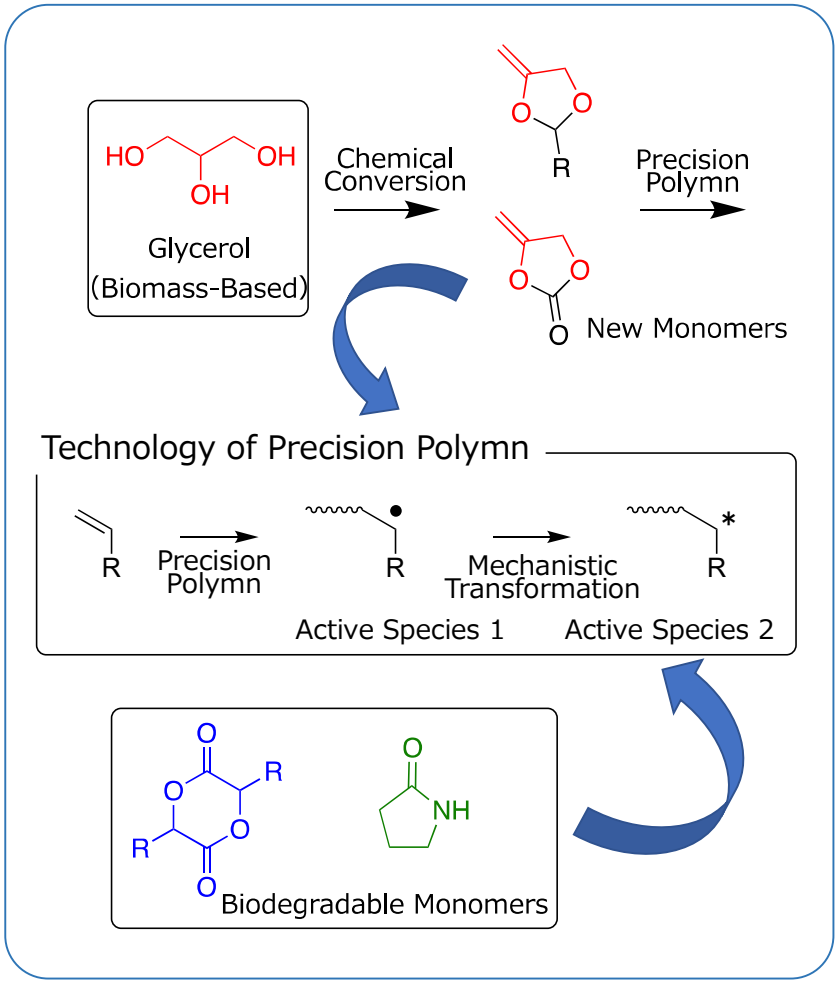
Implementing organizations : The University of Tokyo, Mitsubishi Chemical Corporation, Bridgestone Corporation, Teijin Limited, Kureha Corporation, Kyushu University, Nagoya University, Yamagata University, Research Institute of Innovative Technology for the Earth (RITE), National Institute of Advanced Industrial Science and Technology (AIST), Ehime University, Tokyo Institute of Technology

Tokyo Institute of Technology
Precision Polymerization of Plant-Derived Monomers for Multi-Locked Degradable Biopolymers

MOONSHOT RESEARCH & DEVELOPMENT PROGRAM NEDO

MS伊藤PJ

For developing multi-locked degradable polymers from non-edible biomass, we will develop a multi-lock technology by utilizing the technology of precision polymerization, which we had cultivated in the petroleum chemicals, to biomass-based and multi-locked degradable polymers. By the polymerization of non-edible biomass as a raw material, we propose the concept of a manufacturing method for multi-lock biopolymers that can be degraded in the ocean collaborating with industry. In particular, we will focus on abundant, inexpensive, non-edible biomass of glycerol, aromatic compound from non-edible biomass, and etc., by converting them into a polymerizable vinyl monomers. We also reported precision polymerization through mechanistic transformation of different active species, which will be applied for introducing biodegradable segments, such as esters and amides, into common polymers.



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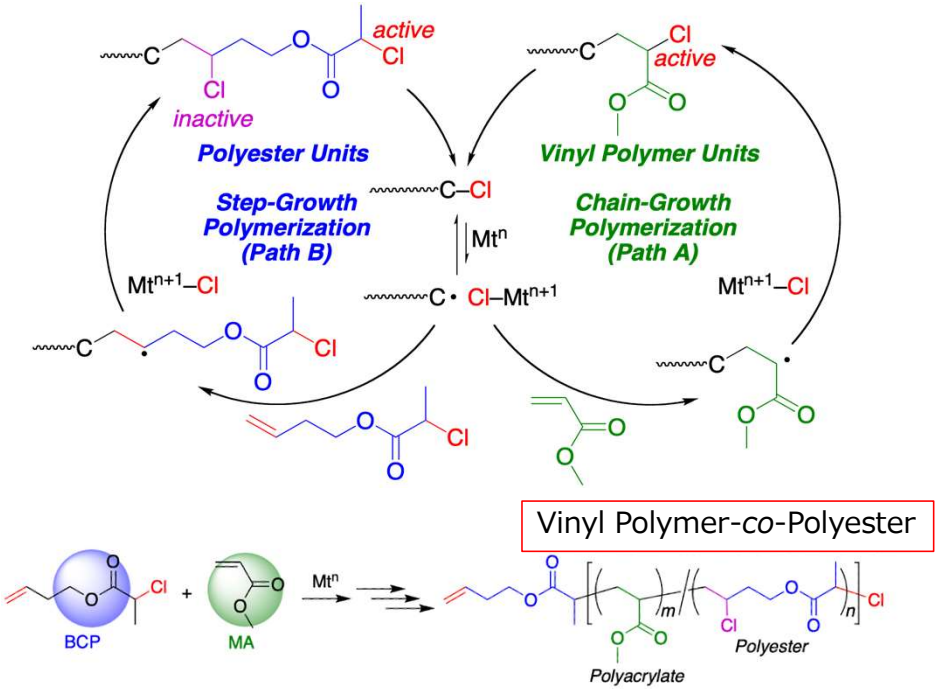
Research Background・Purpose

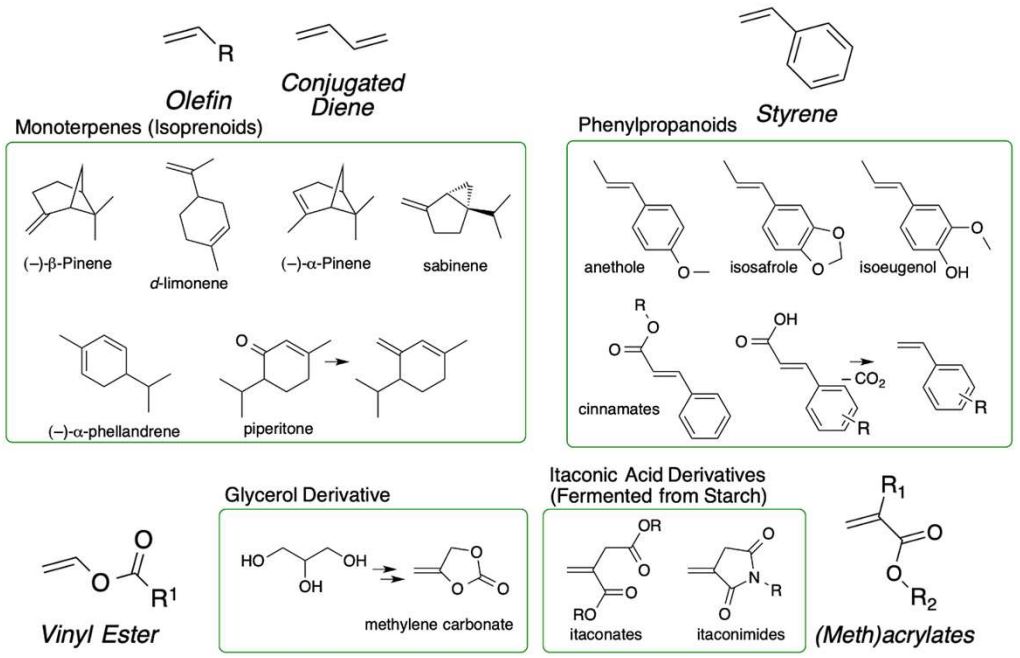
Development of Novel Systems for Precision Polymerization



Vinyl Polymer-*co*-Polyester

K. Satoh, S. Ozawa, M. Mizutani, K. Nagai, M. Kamigaito, *Nat. Commun.* **2010**, 1: 6.
M. Mizutani, K. Satoh, M. Kamigaito, *J. Am. Chem. Soc.* **2010**, *132*, 7498.

New Polymer Material From Non-Edible Plant-Derived Monomers



Satoh, K.; Kamigaito, M. in "Bio-Based Polymers," Kimura, Y. ed., CMC, Japan, 2013.
Satoh, K. *Polym. J.*, **2015**, *47*, 527-536 (Focus Review).

Precision Polymerization of Plant-Derived Monomers for Multi-Locked Degradable Biopolymers

For developing multi-locked degradable polymers from non-edible biomass, we will develop a multi-lock technology by utilizing the technology of precision polymerization, which we had cultivated in the petroleum chemicals, to biomass-based and multi-locked degradable polymers.

Final Goal in 2029

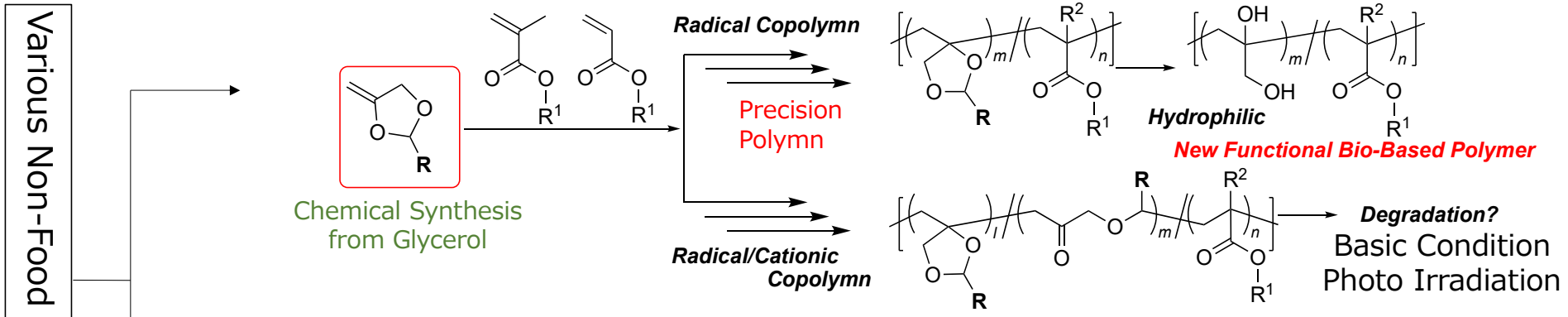
We verify the concept of a manufacturing method for multi-locked biopolymers that can be decomposed in the ocean upon multiple stimulus in collaboration with industry.

E3-1d

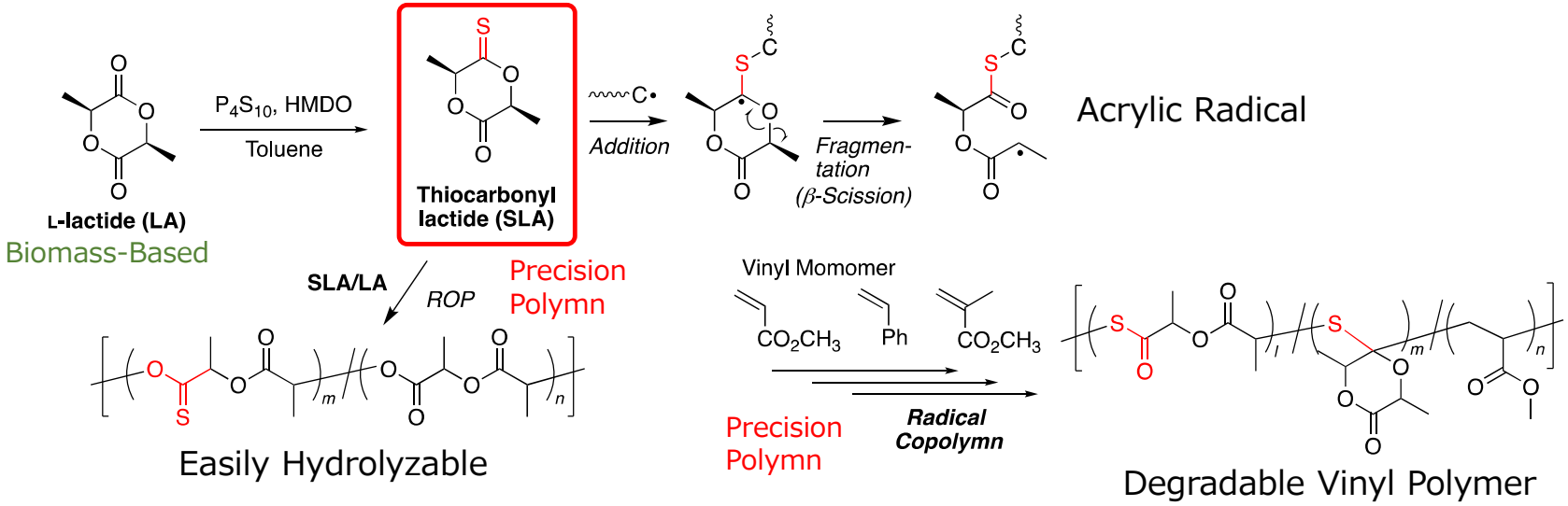
Precision Polymerization of Plant-Derived Monomers for Multi-Locked Degradable Biopolymers

R&D Topics

- Degradable Polymer Synthesis by Polymerization of Novel Biomass-Derived Monomers



- Introducing Degradable Units Using the Fundamental of Precision Polymerization



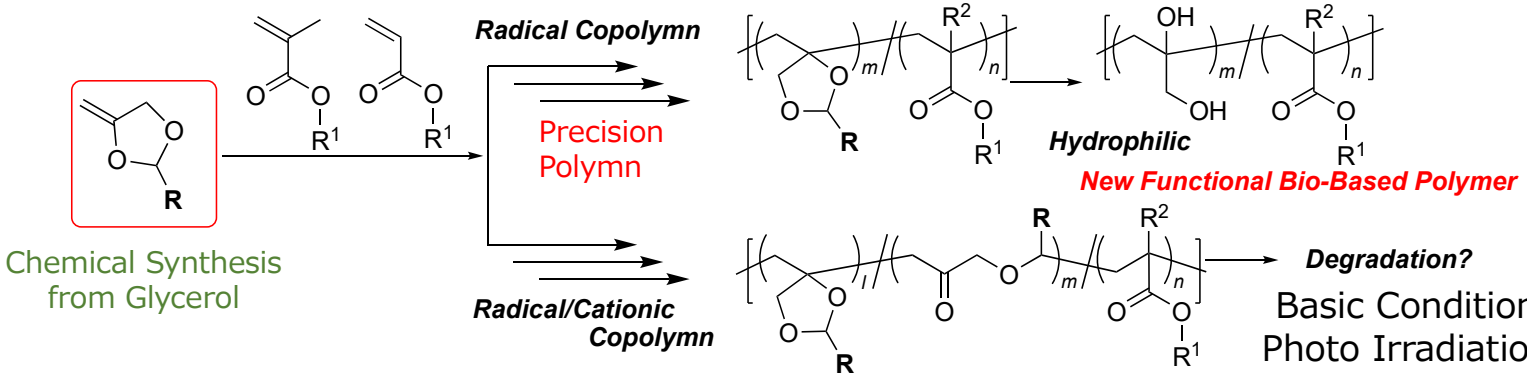
Collaboration with Industry

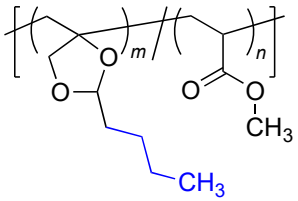
Various Bio-Based Monomer Copolymerization / Degradation Technologies

Results

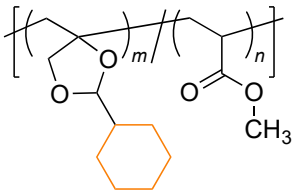
- Degradable Polymer Synthesis by Polymerization of Novel Biomass-Derived Monomers

Polymerization of Glycerol-Derived Vinyl Ethers

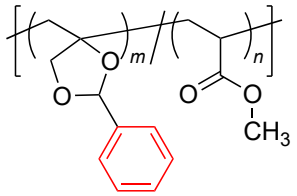




BMDO/MA
M_n = 7000
M_w/M_n = 1.32
m : *n* = 40 : 60 (NMR)
47 : 53 (calcd)

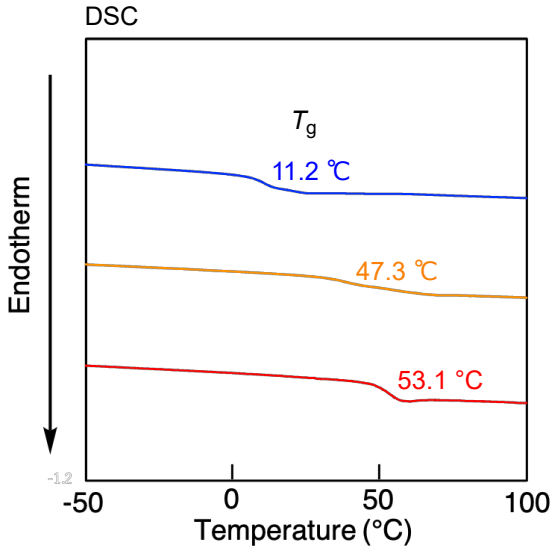


CHMDO/MA
M_n = 8900
M_w/M_n = 1.33
m : *n* = 42 : 58 (NMR)
46 : 54 (calcd)

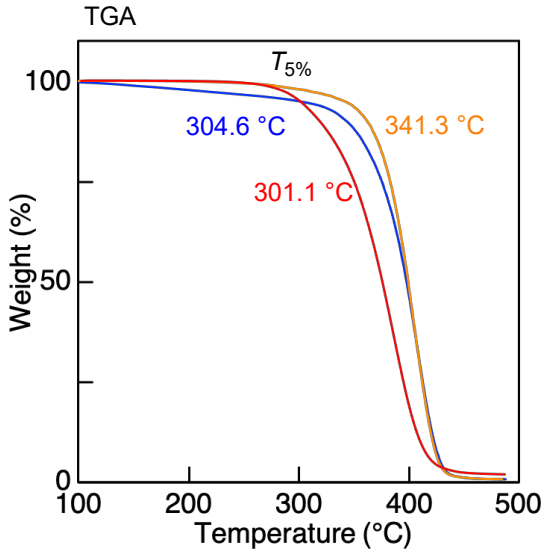


PhMDO/MA
M_n = 8500
M_w/M_n = 1.26
m : *n* = 26 : 74 (NMR)
38 : 62 (calcd)

Success in synthesizing bio-based copolymers with various properties



Tg Increased even with low contents



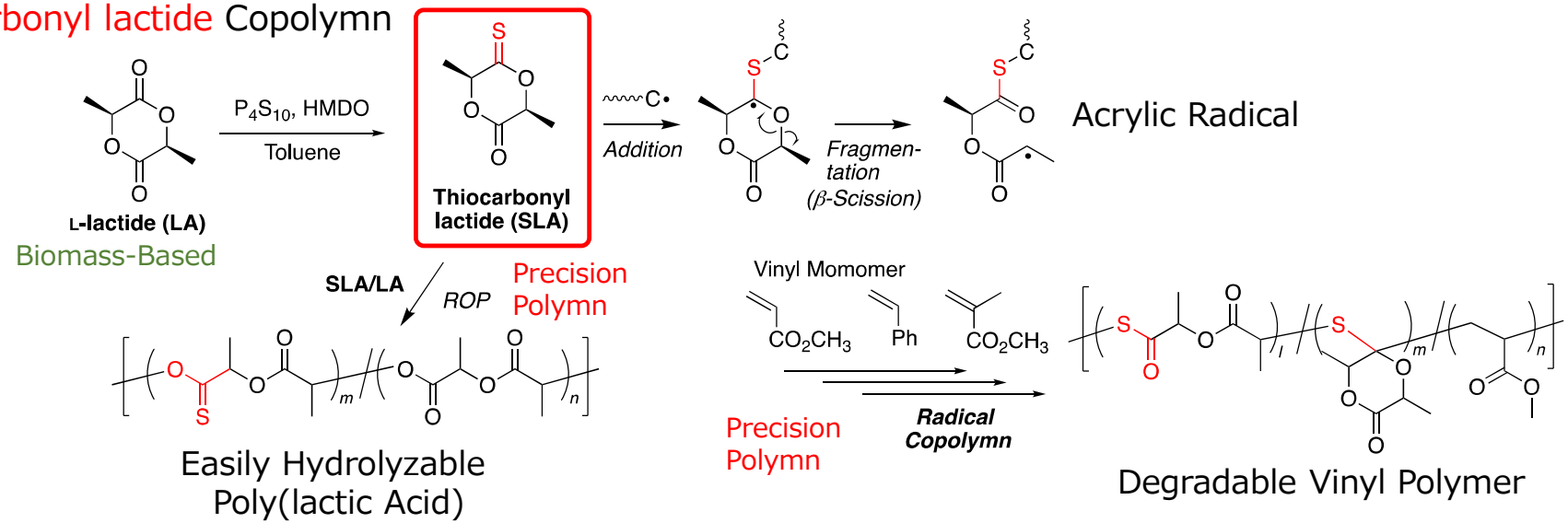
No thermal degradation of pendent acetal

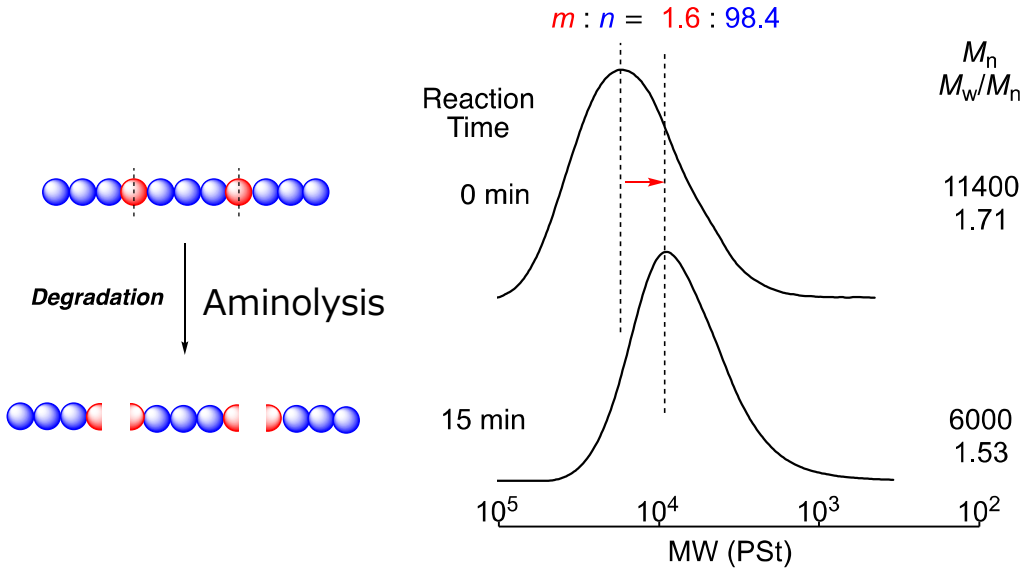
Student awards : Riko Kahima(M1), 70th SPSJ Annual Meeting, Best Poster Award（2021 June 30）

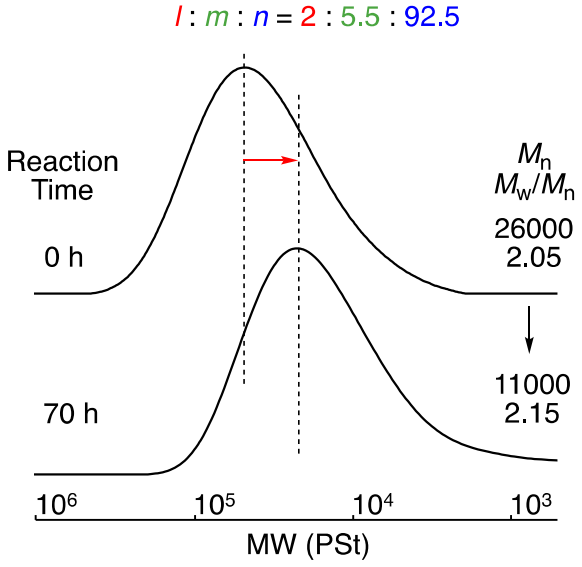
Results

・Introducing Degradable Units Using the Fundamental of Precision Polymerization

Thiocarbonyl lactide Copolymn







Future Plan:
Marine degradability and safety evaluation of decomposition products

We succeeded in both precision synthesis of copolymers, of which main chain degradability was confirmed.

Patent application : JP2021-131293（Application Date : 2001 Aug 11）

Student awards : Ryoya Kamiki (M1) CSJ Chemistry Festa 2021, Best Poster Award（2021 Dec 2）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